Evidence Based Care Journal
http://ebcj.mums.ac.ir/

Effect of an Educational Video Game for Diabetes Self-management on Adherence to a Self-care Regimen in Children with Type 1 Diabetes

Ebrahim Rafeezadeh, Nosrat Ghaemi, Hamid Heidarian Miri, Aramesh Rezaeian

The online version of this article can be found at
http://ebcj.mums.ac.ir/article_13508.html

Evidence Based Care Journal 2019 09:74 originally published online July 2019
DOI: 10.22038/ebcj.2019.40293.2058

Online ISSN: 2008-370X

Address: Mashhad Nursing and Midwifery School, Ebn-e-Sina St., Mashhad, Iran
P.O.Box: 9137913199
Tel.: (098 51) 38591511-294
Fax: (098 51) 38539775
Email: EBCJ@mums.ac.ir

Evidence Based Care Journal

Original Article

OPEN ACCESS JOURNALS

Effect of an Educational Video Game for Diabetes Self-management on Adherence to a Self-care Regimen in Children with Type 1 Diabetes

Ebrahim Rafeezadeh[1], Nosrat Ghaemi[2], Hamid Heidarian Miri[3], Aramesh Rezaeian[4*]

Received: 19/05/2019
Accepted: 20/07/2019

Evidence Based Care Journal, 9 (1): 74-83

Abstract

Background: Type 1 diabetes is known as the most common endocrine disorder in children which requires strict adherence to self-care regimen. Accordingly, children's exposure to educational video games can be a strategy for promoting adherence to such regimens.

Aim: The main purpose of this study was to investigate the effect of an educational video game for diabetes self-management on adherence to self-care regimens in children with type 1 diabetes.

Method: This two-group randomized clinical trial was conducted on 68 children aged 8-12 years affected with type 1 diabetes and admitted to Akbar Children's Hospital in Mashhad, Iran, during 2018. A self-care package for children with type 1 diabetes was extracted using a review method. The intervention group played the designed interactive video game. Data were analyzed in SPSS software (version 16) through independent t-test and Mann Whitney U test.

Results: Both study groups were homogeneous in terms of demographic characteristics. Based on the results of independent t-test, no significant difference was observed between the intervention (77.5±10.1) and control groups (78.7±7.4) regarding mean self-care scores before intervention (P=0.57). However, mean self-care score in the intervention group (82.9±7.8) was significantly higher than that in control group (77.3±7.7) after the intervention (P=0.57). Intra-group comparisons also confirmed the above-mentioned findings.

Implications for Practice: The designed educational video game could significantly improve children's self-care scores. Given that Internet-based video games can be manipulated and quickly updated, it was suggested to compare online and offline video games in future studies.

Keywords: Children, Diabetes, Self-care, Video games

1. MSc Student in Pediatric Nursing, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran
2. Associate Professor, Pediatric Endocrine and Metabolism, Mashhad University of Medical Sciences, Mashhad, Iran
3. Assistant professor of Epidemiology, Social Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.
4. Instructor, Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

* Corresponding author, Email: rezaeiana@mums.ac.ir

Introduction

Type 1 diabetes is known as the most common endocrine disorder in children and adolescents (1). Over the past two decades, the global prevalence of this disorder has also significantly increased (2) and the findings of epidemiological studies have demonstrated a rising trend in diabetes in Iran (3). Poverty and inadequate knowledge, skills, and education have further augmented risks of diabetic complications accompanied by economic burdens (4). In addition, diabetes has been classified among chronic disorders with no definitive treatments but manageable. One of the principles of diabetes control is patients' adherence to therapeutic and self-care regimens leading to improved blood glucose level control which will reduce the complications of the disease (5).

However, the majority of patients fail to adhere to such regimens (6). Therefore, poor self-care results in inadequate blood glucose level control, which has been recognized as a serious problem for many children with diabetes and can cause adverse complications or early death (7). Failure to follow recommended regimens is a complex behavioral process which can be affected by several factors, such as patients' demographic characteristics, physician-patient interactions, and health care systems (8).

Regarding three main pillars of medication, diet, and exercise as treatments for each disease, the fourth pillar is undoubtedly education (9). In the meantime, nurses can make use of strategies tailored to children's levels of development and, in this way, design proper and effective self-care programs (10). In this regard, previous studies have demonstrated that promoting knowledge and self-care skills in diabetes can reduce diabetes-related emergencies, lower medical costs, and consequently improve the quality of life in patients (11).

Although individual educational programs are much more effective to meet these objectives, such programs are costly and this issue limits their application for the general public (12). On the other hand, conventional and non-active teaching methods, such as oral presentations, brochures, or pamphlets that are economically cost-effective have failed to improve clinical outcomes (13). To meet these needs, updated supportive systems have developed evidence-based interventions in order to boost the quality of education and improve patients' clinical outcomes and also guarantee the cost-effectiveness

Video games are among the latest alternative methods that are utilized as tools to improve knowledge and self-care skills as well as methods for disease treatment and management (14), which have resulted in a branch of science and technology labeled as computer-based instruction (CBI). The CBI include significant advantages, such as no time and space limitations, better retention of information, multimedia functionality, more accessibility, personal education, simultaneous presentation of contents, relevance of contents to audience progress, active involvement of audience, ability to be adapted to individuals' needs at a lower cost, and capability to store and retrieve a large amount of information that can enhance learners' motivation (15).

One of the sub-branches of CBI, which converted the learning from a boring and frustrating activity into an amusing and exciting one, is the use of video games as educational mediators that can create a unique combination of fun, encouragement, motivation, repetition, operator feedback, and feedback reception (16).

Among the issues highlighting the use of educational video games for children affected with diabetes is the very diverse volume of knowledge that these individuals need for achieving self-sufficiency in self-care. In this respect, the American Association of Diabetic Educators has identified seven behavioral habits in this population of patients that need to be improved in order to achieve self-care adequacy, including being active, having healthy diet, receiving medications, monitoring blood glucose level, learning problem-solving skills, reducing risks, and showing adherence (17).

It is inevitable to present this knowledge earlier as well as convert it into behavioral changes. Although the school age is the onset of academic education and given that learning at this age is exciting for children, this volume of knowledge based on levels of cognitive development in children is demanding and annoying. However, the learning based on educational video games can create allure in players and stimulate them to assume roles and responsibilities on a regular basis for a long term (14). Accordingly, a high volume of the required knowledge can be included in a stage-by-stage educational video game and presented to children over time. Such video games in which the requirement of entering into the next stage is a success in the previous one seem to be effective in enhancing children's skills. These are capabilities that are difficult to achieve through conventional learning tools and methods (18).

Regarding the importance of type 1 diabetes and its effect on individuals, families, and communities, and considering the extensive self-care responsibilities of these children to control their blood glucose level, it is of utmost importance to implement effective interventions to improve their self-care behaviors and skills (19). This requires the use of educational aids tailored to cognitive development in children. Accordingly, the present study aimed to investigate the effect of an educational video game for diabetes self-management on adherence to self-care regimen in children with type 1 diabetes.

Methods

This two-group randomized clinical trial was conducted on children affected with diabetes within the age range of 8-12 years at the Endocrine Department of Akbar Children's Hospital in Mashhad, Iran during 2018. The participants were selected through convenience sampling technique and they were allocated to intervention and control groups via simple random sampling method. The inclusion criteria in this study were: 1) children aged between 8 and 12 years, 2) no family history of diabetes, 3) having parents or legal guardians, 4) lack of any other disorders, such as thyroid disorders, congenital anomalies, and learning difficulties, 5) lack of participation in any educational programs on diabetes self-management over the last 6 months, 6) literacy ability of parents and children (i.e., at least reading and writing literacy), and 7) the existence of a desktop computer or a laptop in families to install the video game software programs.

On the other hand, the parents of children or the children who were unwilling to continue the study, children who played the video game less than an hour or more than four hours a week, and those children whose one of their close relatives died during the research were excluded from the study. The sample size was calculated using the formula of "Determining the minimum sample size based on the comparison of the mean and standard deviation of two populations" on the basis of the total score of adherence to self-care regimens in the intervention (78.3±0.4) and control groups (75.2±4.9). Moreover, the sampling was performed considering a 95% confidence interval (CI) and 80% test power based on a pilot study by 33 patients in each group. Eventually, with regard to sample attrition, 35 patients were assigned to each group.

Data were collected using a participant selection form developed and completed based on the inclusion and exclusion criteria by the researcher and a demographic characteristics information form focusing on personal characteristics of the participants that was developed by the researcher and completed by parents in the presence of children. Moreover, a 20-item researcher-made Diet and Exercise Regimen Adherence Questionnaire for Children with Diabetes was employed to collect data in this study. This instrument is scored based on a Likert-type scale ranged from 20 to 100.

The total score of adherence to self-care regimens was the sum of the scores in these three dimensions, which included minimum and maximum scores of 20 and 108, respectively. The glycosylated hemoglobin (HbA1c) levels in patients were also measured and analyzed before and after intervention as supplementary findings.

The researcher-made Diet-Exercise Regimen Adherence Questionnaire was designed based on the review of valid texts (20, 22) and its validity was examined based on content validity and of comments 8 faculty members in the field of endocrinology and metabolic diseases in pediatric nursing. Its reliability was also measured using the test-retest method through Pearson correlation coefficient by 0.82.

The present study was carried out in two stages. At the stage before the intervention, the self-care package for children with diabetes was extracted by a review of the related literature. The final version of the given package was obtained after several revisions. Subsequently, this package was converted into scenarios to design educational video games. Scenarios were then designed with the main titles of diet, exercise, medication, hypo/hyperglycemia symptoms, preventive care, care for injuries, and general health.

At the next stage, the game was made based on the scenarios designed according to the self-care package. The final product was an educational interactive video game that could provide positive or negative feedback on children's performance in line with their choices or operations. Each stage of the game began with a short educational clip on a special self-care topic. Afterward, the child was given the opportunity to play the game and make choices in accordance with what had been presented in the educational clip. For instance, in the section related to diet, one of the games was making right

and defined number of choices of foodstuff (i.e., lettuce, French fries, chocolate, cakes, carrots, ice cream, and apple) scrolling down the computer screen within a certain time.
In this respect, incorrect choices, such as ice cream could lead to negative points and correct choices, such as carrot could receive positive points. To pass each stage and to enter into the next one, a certain amount of positive points would have to be achieved over time. If children could successfully finish each stage and enter into the next one, they could be encouraged by the voice of a child leading the game and consequently received gold stars.
During the intervention stage and after attending the Endocrine Department of Akbar Children's Hospital, the Demographic Characteristics Information Form, the MMAS, and the Diet-Exercise Regimen Adherence Questionnaire were completed simultaneously through interviews with parents and children meeting the inclusion criteria. The test results of HbA1c levels were also recorded in the data collection form provided that they were related to the previous 10 days.
If the patient had no HbA1c test results, or if the results were older than 10 days, a new test was requested. After collecting the basic data, the CD-ROM containing the educational video game was given to the children in the intervention group. The installation method was of autoplay type; however, there was a full description of how to install and set up the software. To control the minimum and maximum use of the software program, the children in the intervention group were requested to play the video game for 12 weeks and at least one hour and a maximum of four hours a week.
The amount of the usage of software was measured using Hour Record Table Forms provided to the parents of children in the intervention group, and they were asked to return the forms at the end of the intervention. An upper limit for playing hours was adopted from the ethical point of view to notify children not to spend their time on this video game for more than four hours per week since children with diabetes must be active enough.
A contact number was given to children's families to inform the researcher in case of any possible problems with the software. The intervention lasted for three months. During these three months, all the children in the intervention group were contacted two times (10 and 30 days after the delivery of the software) to answer their possible problems and questions and to monitor the intervention.
During these three months of intervention, one individual in the intervention group and one child in the control group withdrew from the study due to a computer crash and lack of consent, respectively. The number of participants was 34 individuals in each group at the end. After three months of the intervention, the HbA1c levels and the parameters of adherence to the diet, exercise, and medication regimens were measured in both study groups. Families were then invited to Akbar Children's Hospital on certain days (depending on the time they entered into the study). The Hour Record Table Forms were initially checked to exclude them if the minimum requirements had not been met. It should be noted that no one was removed at this stage.
This project was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran. Prior to inclusion, informed consent was obtained from parents for the involvement of their children in the study. As well, 24 codes of ethics in clinical trials were taken into consideration and the children in the control group also received the educational video game CD-ROM and the required training after completion of the study to observe ethical issues.
The data were also analyzed in SPSS software (version 16). To describe the characteristics of the participants in each group, descriptive statistics of central tendency and dispersion such as mean, standard deviation, and frequency distribution were used in this study. After determining the normal distribution of the data using the Kolmogorov-Smirnov test and Shapiro-Wilk test, paired t-test, independent t-test, and Mann-Whitney U test were employed if needed.

Results

After excluding one individual in the control group and one in the intervention group, a total number of 34 patients in each group were examined and analyzed. According to the results, 19 (55.9%) and 20 children were male (58.8%) in the intervention and control groups, respectively. The results of the Chi-square test did not show any significant difference between the two groups regarding gender distribution. Other demographic characteristics information is illustrated in Table 1. Based on the results of independent t-test, there were no significant differences between the intervention (77.5±10.1) and control groups (78.7±7.4) regarding the mean scores of self-care before the intervention (P=0.57). However, based on the results of the independent t-test, the intervention

group obtained significantly higher scores (82.9±7.8) than the control group (77.3±7.7) in terms of mean self-care score after the intervention (P=0.004). Considering the scores of adherence to self-care regimen and based on the results of the independent t-test, the scores of adherence to a diet regimen (38.6±5.7) and an exercise regimen (35.1±5.7) were significantly higher in the intervention group than those of diet (38.1±2.4) and exercise (35.9±7.4) in the control group. However, the results of the independent t-test showed no significant difference between the intervention (7.3±1.5) and control groups (7.7±1.4) regarding the mean HbA1c level (P=0.27). In the same line, no significant differences were observed between the intervention (6.2±0.9) and control groups (6.2±0.9) in terms of mean adherence to medication regimen (P=0.88, tables 2 and 3). In order to control the effect of confounding variables on the effectiveness of the intervention, the modeling was completed using linear regression based on the assigned group, age, gender, and self-care scores before intervention (Table 4). According to this table, age and gender did not have a

Table 1. Mean and standard deviation of demographic characteristics of children with diabetes in intervention and control groups

Variable	Group		Test results
	Intervention n=34	Control n=34	
	Mean±SD	Mean±SD	
Age (year)	9.9±1.4	10.4±1.2	*P=0.083
Height (cm)	129.8±12.3	132.8±7.9	**P=0.23
Weight (kg)	30.5±8.8	31.6±5.8	**P=0.53
Body mass index (kg/m^2)	18.1±4.5	18.1±3.8	**P=0.98

*Mann-Whitney U test
**Independent t-test

Table 2. Mean and standard deviation of adherence to self-care regimen in children with diabetes before and after the intervention in the intervention and control groups

Variable	Stage	Group		Inter-group test results
		Intervention n=34	Control n=34	
		Mean±SD	Mean±SD	
Diet	Before intervention	36.7±7.0	35.5±5.8	*P=0.26
	After intervention	38.6±45.7	35.1±5.7	**P=0.01
	Intra-group test results	***P=0.01	***P=0.45	
Exercise	Before intervention	34.7±4.7	36.9±4.2	**P=0.06
	After intervention	38.1±4.2	35.9±4.7	**P=0.04
	Intra-group test results	***P<0.001	***P=0.51	
Medication	Before intervention	6.0±1.1	6.4±1.0	**P=0.27
	After intervention	6.02±0.9	6.2±0.9	**P=0.88
	Intra-group test results	***P=0.18	***P=0.41	
The total score of adherence to self-care regimens	Before intervention	77.5±10.1	78.7±7.4	**P=0.57
	After intervention	82.9±7.8	77.3±7.7	**P=0.004
	Intra-group test results	***P<0.001	***P<0.001	

*Mann-Whitney U test
**Independent t-test
***Paired t-test

Table 3. Mean and standard deviation of HbA1c levels in children with diabetes before and after the intervention in the intervention and control groups

HbA1c	Group		Inter-group test results
	Intervention n=34	Control n=34	
	Mean±SD	Mean±SD	
Before intervention	7.4±1.7	7.9±1.6	*P=0.09
After intervention	7.3±1.5	7.7±1.4	**P=0.27
Intra-group test results	***P=0.78	***P=0.19	

Table 4. Results of linear regression to determine the effect of the intervention on self-care scores after matching them based on self-care scores before the intervention, group, age, and gender

Independent variable	Coefficient	Standard error	P-value	95% CI	
Self-care scores before intervention	0.65	0.07	0.001	(0.50, 0.80)	
Group	-13.37755	2.61663	P<0.001	-18.60647	-8.148633
Age	1.24429	1.011048	0.223	-.7761285	3.264708
Gender	-2.177378	2.599379	0.405	-7.371822	3.017067
Intercept	65.98275	16.03655	P<0.001	33.93626	98.02923

significant effect on the results of the study. However, the effect of the assigned group (P<0.001) and that of self-care scores before intervention (P<0.001) were significant on self-care scores after the intervention.

Discussion

The results of this study suggested that the use of an educational video game for diabetes self-management in children with type 1 diabetes had significantly increased the total scores of adherence to self-care regimens. These changes were mostly observed in terms of adherence to diet and exercise. As shown in Table 4, the effect of group on the total scores of adherence to self-care regimens in the designed model was significantly higher; however, the confounding variables of gender and age had no significant effect on the results. Consequently, the observed changes in the intervention group could be significantly associated with the intervention. In this respect, the results of a systematic review and meta-analysis conducted by Charlier et al. (2015) on the effectiveness of targeted video games in knowledge and practice of self-care strategies among children with chronic conditions also confirmed the findings of the present study.

Charlier et al. (2015) examined nine studies related to the effect of video games on knowledge and self-care skills of children and adolescents with chronic diseases. They found that such games had been used in health education, physical training, treatment of diseases, prevention and health promotion, exclusive health outcomes, as well as health professionals training. The final results of their study indicated that video games had potentials to improve knowledge, skills, attitudes, behaviors, and performance of patients in relation to their illnesses and consequently led to improved health outcomes (14). These results were consistent with the findings of the present study in terms of the effect of an exclusive educational self-care video game for diabetes self-management on the scores of adherence to self-care regimens. The review of the related literature suggested that Brown et al. (1997) conducted the first study as a clinical trial in the same context. They employed an interactive game called Packy and Marlon to improve self-care in children and adolescents with type 1 diabetes within a 6-month period.

In the given game, the players could assume the role of a cartoon character affected with diabetes and manage it by controlling blood glucose level, injecting insulin, and choosing foodstuff, while fighting with mice who were trying to steal food supplies of diabetics. They found that the given game had boosted self-efficacy and self-care behaviors associated with diabetes; however, it did not have a significant effect on HbA1c levels (23). Kumar et al. (2004) also carried out a similar study in order to test the effect of DAILY (Daily Automated Intensive Log for Youth) as a software program. They installed this software on a wireless portable device and connected it to a central server to be used by the intervention and control groups. In addition, the intervention group was also equipped with a motivational game.

The final results showed that the control group had higher blood glucose levels, compared to those in the intervention group. Moreover, the level of knowledge of children in the intervention group during 4 weeks was significantly improved, compared to those in the control group (24). This investigation correspondingly supported the findings of the present study. As observed, video games are being used as a strategic approach to improve health outcomes. The main mechanism of action for achieving clinical positive outcomes seems to be the capacity of these games to create and increase motivation in children (25). Motivation is also usually the most important parameter in self-care since it requires patients undergo specific procedures or change particular behaviors that may be painful and horrific (e.g., injection of insulin) or boring and frustrating (e.g., taking medications for a long term or doing

regular and long-term physical exercises). However, it is obvious that such procedures and behaviors are necessary to sustain patient health or to achieve recovery (26).

In the same line, another mechanism of action of video games in terms of obtaining positive clinical outcomes is the distraction of patients' focus from annoying, boring, and frustrating self-care practices to a refreshing game, learning in the context of a game, testing learning, gaining points for proper actions, and promoting in the stages of a game. Moreover, the nature of the repetition of video games can be one of the key mechanisms of action for promoting knowledge in children and changing their behaviors (27). All these mechanisms can be achieved during playing with a video game for education and entertainment. Therefore, the use of game theories is helpful to understand how a game can affect a child. The game is usually optional, and it inherently has the nature of an induction which is amusing for a player. Furthermore, regardless of any external rewards in this regard, it entails different degrees of physical exercise and is different from other behaviors and activities depending on the nature of the beliefs.

The psychoanalytic theory also considers the games as tools by which a child can experience catharsis or escape fears or tensions in a safe and secure environment. From this conceptual perspective, a game is a strategy for stress management. Therefore, a game can play a key role in aiding children to manage the annoying or embarrassing aspects of their illness. Additionally, symbolic interactionist theories have considered games as tools for children to understand their surrounding world. Such games with a role-playing nature can thus aid children to learn different social roles they may assume in society (28). These roles can be associated with self-care and self-management of disease conditions. Role-play also teaches players how to expand a sense of empathy and appreciate others' feelings and attitudes. It is similarly a form of play that facilitates self-management opportunities through fulfilling self-care scenarios in a safe and secure learning environment (29).

As noted in the findings, the adherence to a diet regimen had significantly increased in the intervention group. Comparably, Rezaei (2006) in his study considered nutrition education as a strategy affecting knowledge, attitudes, and practices concerning self-care in patients with type 1 diabetes (30), which was in line with the findings of the present study. This comparison suggested that the educational use of games could be as effective as conventional classroom instruction in adults in terms of achieving behavioral outcomes. This interpretation was verified by the theory that children can learn while playing and their learning is effective once they play fantasy games which compel them to think (10). Moreover, the educational video game used in this study had a significant effect on adherence to an exercise regimen. In this respect, the study conducted by Zakeri et al. (2008) found that the adherence to an exercise regimen in most of the participants before nurse-led phone follow-up was at a low and undesirable level.

Following this intervention, 43.3% of the participants were reported to be at a desirable level (31). In the same line, in a study performed by Noohi et al. (2011) on the adherence to exercise programs in children with diabetes, both phone and short message services follow-up methods had effects on their exercise and mobility (32). Accordingly, the findings of the previous studies indicated a poor level of adherence to an exercise regimen and mobility in these children. It is noteworthy that children's status in the present study was not constantly monitored with the intervention of an external third person in a fixed manner, and a significant change was made in terms of adherence to the exercise regimen only by participating in the game. This meant the internalization of education was fulfilled through the game.

However, the given educational video game did not have a significant effect on the adherence to diet in a self-care regimen. It seems that one of the reasons for these findings was the inconsistency of the educational content of the given game with MMAS items. Although this questionnaire is one of the most accepted instruments measuring the adherence to medication regimens, it is a very common tool used for many diseases. The items in this questionnaire are very general and small in number that only examines the use or non-use of medications and forgetting a dose. However, the educational video game had paid more attention to educational aspects and medication-related details, especially executive techniques.

Finally, the child did not have a significant performance in terms of responding to MMAS. Since the children participating in the study were at school age, mothers or fathers rather than children had to bear the burdens of giving medications and doing follow-ups, whereas the children had only been involved in the process of indirect education through the game.

In childhood diabetes education, the quality of medication interventions, as well as importance, technique, and timing of insulin injections, are emphasized more than anything else. In this way, it was likely that the children had been included in the present study with significant education in the field of medication therapy. Nonetheless, it seems that conventional education by the medical staff in terms of diet and exercise regimens does not have enough strength, and children have been prepared to accept new education from these two dimensions.

Among the other findings of this study were examining changes in HbAc1 levels. In this respect, the educational video game for diabetes self-management had no effect on HbAc1 levels over 3 months. The findings of the investigation by Huang et al. (2009) were thus in agreement with the results of the present study. Huang et al. (2009) also found that educational intervention using interactive multimedia had no significant effect on HbAc1 levels in both study groups (33).

The investigation by Brown et al. (1997) similarly showed no significant effect on HbAc1 levels in both study groups despite lasting for 6 months (23). Moreover, Salsali (2013) conducted a study on the effect of education based on the Symptom Focused Management Model on HbAc1 level, knowledge, and self-care behaviors in pregnant women with type 2 diabetes. The results revealed that the reduction of HbAc1 levels in the intervention group was not significant, although significant changes were observed in their self-care behaviors (34). The above-mentioned findings confirmed the results of the present study. It should be noted that although HbAc1 level is often used to monitor long-term glucose level control, several factors, including genetic variations in hemoglobin, chemical modifications on hemoglobin variants, ferritin blood levels, and serum albumin levels can influence blood level measurements (35) which can limit its research applications.

One of the limitations of the present study was that parents had not recorded the game duration exactly and what had been reported was whether children had played the game less than one hour or over four hours or not. The duration of the game was not among the objectives of the present study; however, it could provide additional analyses.

Implications for Practice

The results of this study could have implications in the field of clinical nursing, specifically at Endocrinology Departments, Emergency Departments, and Therapeutic-Educational Centers of diabetes to facilitate self-care practices to newly-diagnosed children since the most important self-care needs in these children are teaching self-care in different dimensions which can lead to better control of the disease. Therefore, it is suggested to conduct further studies to improve the level of games and the richness of existing educational practice and to add self-care items, and especially to compare online and offline methods. The online nature of the game can provide additional analyses for the researchers. Moreover, a more specific research tool is required to examine the dimension of adherence to medication regimens to focus more on the measurement of details and techniques of implementing medication regimens instead of use or non-use of medications.

Acknowledgments

The present study was extracted from a thesis entitled “Effect of an Educational Self-Care Video Game on Medication Regimen and Glycosylated Hemoglobin Levels in Children with Diabetes” funded by the Research Deputy of Mashhad University of Medical Sciences, Mashhad, Iran. The project was archived in Iranian Registry of Clinical Trials with the code no. IRCT20171019036880N1 and also approved with the code of ethics of IR.MUMS.REC.1396.390 by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran. The authors, hereby, express their sincere gratitude to the Vice-Chancellor’s Office for Research at Mashhad University of Medical Sciences, as well as President, the Vice-Chancellor’s Office for Education, and the staff of the Pediatric Endocrinology Department of Akbar Children’s Hospital.

Conflicts of Interest

The authors declared no conflict of interest.

References

1. Faulkner MS, Chang LI. Family influence on self-care, quality of life, and metabolic control in school-age children and adolescents with type 1 diabetes. J Pediatr Nurs. 2007;22(1):59-68.
2. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010;87(1):4-14.
3. Larejani B, Zahedi F. Epidemiology of diabetes mellitus in Iran. Iran J Diabetes Metab. 2001;1(1):1-8.
4. Kennedy A, Gask L, Rogers A. Training professionals to engage with and promote self-management. Health Educ Res. 2005;20(5):567-78.
5. Paquot N. Deleterious effects of lack of compliance to lifestyle and medication in diabetic patients. Rev Med Liege. 2010;65(5-6):326-31.
6. Harvey J, Lawson V. The importance of health belief models in determining self-care behaviour in diabetes. Diabet Med. 2009;26(1):5-13.
7. Albano MG, Crozet C, d'Ivernois JF. Analysis of the 2004-2007 literature on therapeutic patient education in diabetes: results and trends. Acta Diabetol. 2008;45(4):211-9.
8. Hadi N, Rostami GN, Jafari P. A study on the determining factors for compliance to prescribed medication by patients with high blood pressure. Jundishapur Sci Med J. 2005;4(4):223-9.
9. Padgett D, Mumford E, Hynes M, Carter R. Meta-analysis of the effects of educational and psychosocial interventions on management of diabetes mellitus. J Clin Epidemiol. 1988; 41(10):1007-30.
10. Hockenberry MJ, Wilson D. Wong's essentials of pediatric nursing: Wong's essentials of pediatric nursing. 10th ed. New York: Elsevier Health Sciences; 2016.
11. Ahmann AJ. Guidelines and performance measures for diabetes. Am J Manag Care. 2007; 13(Suppl 2):S41-6.
12. Battersby M, Von Korff M, Schaefer J, Davis C, Ludman E, Greene SM, et al. Twelve evidence-based principles for implementing self-management support in primary care. Jt Comm J Qual Patient Saf. 2010;36(12):561-70.
13. Nascimento LdS, de Gutierrez MG, De Domenico EB. Educative programs based on self-management: an integrative review. Rev Gaucha Enferm. 2010;31(2):375-82.
14. Charlier N, Zupancic N, Fieuws S, Denhaerynck K, Zaman B, Moons P. Serious games for improving knowledge and self-management in young people with chronic conditions: a systematic review and meta-analysis. J Am Med Inform Assoc. 2015;23(1):230-9.
15. Keulers BJ, Spauwen PH. Can face-to-face patient education be replaced by computer-based patient education? Eur J Plast Surg. 2003;26(6):280-4.
16. Ventura M, Shute V, Zhao W. The relationship between video game use and a performance-based measure of persistence. Comp Educ. 2013;60(1):52-8.
17. Zgibor JC, Peyrot M, Ruppert K, Noullet W, Siminerio LM, Peeples M, et al. Using the American association of diabetes educators outcomes system to identify patient behavior change goals and diabetes educator responses. Diabetes Educ. 2007;33(5):839-42.
18. Squire K. From content to context: videogames as designed experience. Educ Res. 2006;35(8):19-29.
19. Health Quality Ontario. Continuous monitoring of glucose for type 1 diabetes: a health technology assessment. Ont Health Technol Assess Ser. 2018;18(2):1.
20. Dumrisilp T, Supornsilchai V, Wacharasindhu S, Aroonparkmongkol S, Sahakitrungruang T. Factors associated with glycemic control in children and adolescents with type 1 diabetes mellitus at a tertiary-care center in Thailand: a retrospective observational study. Asian Biomed. 2017;11(6):443-50.
21. Walsh KE, Cutrona SL, Kavanagh PL, Crosby LE, Malone C, Lobner K, et al. Medication adherence among pediatric patients with sickle cell disease: a systematic review. Pediatrics. 2014;134(6):1175-83.
22. Thuret I, Hacini M, Pégourié-Bandelier B, Gardembas-Pain M, Bisot-Locard S, Merlat-Guitard A, et al. Socio-psychological impact of infused iron chelation therapy with deferoxamine in metropolitan France: ISOSFER study results. Hematology. 2009;14(6):315-22.
23. Brown SJ, Lieberman DA, Gemeny B, Fan YC, Wilson D, Pasta D. Educational video game for juvenile diabetes: results of a controlled trial. Med Inform. 1997;22(1):77-89.
24. Kumar VS, Wentzell KJ, Mikkelsen T, Pentland A, Laffel LM. The DAILY (Daily Automated

Intensive Log for Youth) trial: a wireless, portable system to improve adherence and glycemic control in youth with diabetes. Diabetes Technol Ther. 2004;6(4):445-53.
25. Gros B. Digital games in education: the design of games-based learning environments. J Res Technol Educ. 2007;40(1):23-38.
26. Osborn CY, Egede LE. Validation of an information–motivation–behavioral skills model of diabetes self-care (IMB-DSC). Patient Educ Couns. 2010;79(1):49-54.
27. Rosas R, Nussbaum M, Cumsille P, Marianov V, Correa M, Flores P, et al. Beyond Nintendo: design and assessment of educational video games for first and second grade students. Comp Educ. 2003;40(1):71-94.
28. Kato PM. Video games in health care: closing the gap. Rev Gen Psychol. 2010;14(2):113-21.
29. Smyth JM. Beyond self-selection in video game play: an experimental examination of the consequences of massively multiplayer online role-playing game play. CyberPsychol Behav. 2007;10(5):717-21.
30. Rezaei N, Tahbaz F, Kimyagar M, AlaviMajd H. The effect of nutrition education on knowledge, attitude and practice of type 1 diabetic patients from Aligoodarz. J Shahrekord Univ Med Sci. 2006;8(2):52-9.
31. Zakerimoghadam M, Bassampour SH, Rjab A, Faghihzadeh S, Nesari M. Effect of nurse-led telephone follow ups (tele-nursing) on diet adherence among type 2 diabetic patients. J Hayat. 2008;14(2):63-71.
32. Noohi E, Khandan M, Mirzazadeh A. Effectiveness of electronic education on knowledge attitude and self-care in patient's diabetic type 2 refer to diabetic center of Kerman University of medical science. Iran J Nurs Res. 2011;6(22):73-80.
33. Huang JP, Chen HH, Yeh ML. A comparison of diabetes learning with and without interactive multimedia to improve knowledge, control, and self-care among people with diabetes in Taiwan. Public Health Nurs. 2009;26(4):317-28.
34. Salsali M, Salehi H, Noktehdan H, Hoseini M, KhoshNiyat Nikoo M, Ebrahimi S. Evaluation of the effect of using Symptom Focused Management Model (SFMM) on the amount of HbA1c, knowledge, and self-care behavior of type 2 diabetes patients. Evid Based Care. 2013;3(2):27-36.
35. National Glycohemoglobin Standardization Program. Factors that interfere with HbA1c test results. Columbia: National Glycohemoglobin Standardization Program; 2013.